Draft Safety Evaluation Report

on the Construction Authorization Request
for the Mixed Oxide Fuel Fabrication Facility
at the Savannah River Site, South Carolina,
Revision 1

April 2003

Docket No. 70-3098
Duke Cogema Stone & Webster, L.L.C.

U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards

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ACRONYMS

AC	alternating current
AEC	active engineered control
AEGL	Acute Exposure Guideline Level
AFS	alternate feedstock
AHJ	Authorities Having Jurisdiction
ALARA	as low as reasonably achievable
ALI	allowable limit on intake
ALOHA	areal locations of hazardous atmospheres
A-MIMAS	advanced micronized master blend
ANS	American Nuclear Society
ANSI	American National Standards Institute
AOA	area of applicability
AP	aqueous polishing
ARF	atmospheric release fraction
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BA	Bachelor of Arts
BDC	baseline design criteria
BMF	fuel fabrication building
BS	Bachelor of Science
CAAS	Criticality Accident Alarm System
CAM	continuous air monitor
CAR	Construction Authorization Request
CCU	criticality control unit
CEDC	committed effective dose equivalent
CFM	cubic feet per minute
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
CM	configuration management
CRT	cargo restraint transporter
CSE	criticality safety evaluation
DC	direct current
DCF	dose conversion factor
DCP	double contingency principle
DCS	Duke Cogema Stone & Webster
DOE	U.S. Department of Energy
DR	damage ratio
DSER	draft safety evaluation report
DU	depleted uranium
DUO_2	depleted uranium dioxide
EALF	Energy of Average Lethargy causing Fission
ECR	Emergency Control Room
ECRAS	Emergency Control Room Air-Conditioning System
EDMS	electronic data management system
EFT	effluent treatment facility
EIS	Environmental Impact Statement
EMMH	external man-made hazard
ENDF	Evaluation Nuclear Data File
ER	Environmental Report
ERDA	U.S. Energy Research and Development Administration
ERPG	Emergency Response Planning Guidelines
FHA	Fire Hazards Analysis
FM	Factory Mutual
FNMC	Fundamental Nuclear Material Control
FTS	fluid transport system
HA	hazards analysis
HAAW	high alpha activity waste stream (containing uranium, americium, and other radioactive decay products)
HAN	hydroxylamine nitrate
HAZOP	hazard and operability (analysis)
HD	high depressurization
HEPA	high efficiency particulate air
HEU	high enriched uranium
HFE	human factors engineering
HPT	hydrogenated propylene tetramer
HSI	human-system interface
HVAC	heating, ventilation, and air conditioning
ICN	immediate control network
ICRP	International Commission on Radiation Protection
ICSBEP	International Criticality Safety Benchmark Experiments
IEEE	Institute of Electrical and Electronics Engineers
IROFS	items relied on for safety
I&C	Instrumentation and control
ISA	integrated safety analysis
JSHU	jar storage and handling unit
LANL	Los Alamos National Laboratory
LFL	lower flammability limit
LIN	local industrial network
LLW	low level waste

LPF	leak path factor
LWR	light water reactor
MAPE	mean annual probability of exceedance
MAR	material-at-risk
MC&A	material control and accounting
MCC	motor control center
MCNP	Monte Carlo Neutron Photon
MDE	medium depressurization exhaust
MFFF	mixed oxide fuel fabrication facility
MFFP	MOX fresh fuel package
MMIS	manufacturing management and information system
MOX	mixed oxide
MP	mixed oxide process
MPQAP	MOX Project Quality Assurance Plan
MSDS	Material Safety Data Sheet
MTHM	metric tons heavy metal
NCS	nuclear criticality control
NCSE	nuclear criticality safety evaluation
NFPA	National Fire Protection Association
NRC	U.S. Nuclear Regulatory Commission
NPH	natural phenomena hazards
ORNL	Oak Ridge National Laboratory
PAA	preliminary accident analysis
PAG	protective action guide
PBX	public branch exchange
PC	performance categories
PDCF	pit disassembly and conversion facility
PEC	passive engineered control
PEP	personnel and equipment protection
PFOD	probability of failure on demand
PHA	preliminary hazard analysis
PIP	plutonium immobilization pit
PLC	programmable logic controller
Pu	plutonium
PuO_2	plutonium dioxide
PUREX	plutonium uranium reduction extraction
PSSCs	principal structures, systems and components
QA	quality assurance
QL	quality level
RACB	restricted area boundary concentration
RAI	request for additional information
RF	respirable fraction
SA	safety analysis
SAR	safety analysis report
SCALE	Standardized Computer analyses evaluation
SCAPA	DOE Subcommittee on Consequence Assessment and Protective Action
SRS	Savannah River Site
SER	safety evaluation report
SNM	special nuclear material
SPDP	Surplus Plutonium Disposition Program
SRP	standard review plan (NUREG-1718)
SRS	Savannah River Site
SSC	structures, systems, and components
SST	safe secure transport
STEL	short-term exposure limit
S/U	sensitive/uncertainty
TBP	tributyl phosphate
TEDE	Total Effective Dose Equivalent
TEEL	Temporary Emergency Exposure Limit
TLV	threshold limit value
TQ	threshold quantities
TRU	transuranic
TWRS-P	Tank Waste Remediation System Privatization
UBC	Uniform Building Code
UL	Underwriters Laboratories
UO_2	Uranium Dioxide
USL	upper subcritical limit
UPS	uninterruptible power supplies
WAC	waste acceptance criteria
WG	water gauge
WTA	work task agreement
XTN	X-terminal network

List of Acronyms for MFFF Building and System Designations

Buildings	Systems		
BAD Administration Building BAP Aqueous Polishing Area BEG Emergency Diesel Generator Bldg BMF MOX Fuel Fabrication Bldg BMP MOX Fuel Fabrication Area (MOX Processing Area) BRP Reagent Processing Building BSG Standby Diesel Generator Bldg BSH Safe Haven Buildings BSR Shipping and Receiving Area BSW Secured Warehouse Building BTS Technical Support Building	BAS Breathing Air System CHH HVAC Chilled Water System CHP Process Chilled Water System DCE PuO_2 Buffer Storage Unit DCM PuO_2 3013 Storage Unit DCP PuO_2 Receiving Unit DCS Decontamination System DDP $U0_2$ Drum Emptying Unit DMW Demineralized Water System DRS $U0_2$ Receiving and Storage Unit EGF Emergency Diesel Generator Fuel Oil System GAH Argon/Hydrogen System GDE Rod Decladding Unit GHE Helium System GME, GMF Rod Cladding & Decontamination Units GMK Rod Tray Loading Unit GNO Nitrogen Oxide System GNS Nitrogen System GOX Oxygen System HDE High Depressurization Exhaust System HWS Process Hot Water System IAS Instrument Air System KCA Oxalic Precipitation & Oxidation Unit KCB Homogenization Unit KCC Canning Unit	KCD Oxalic Mother Liquor Recovery Unit KDA Decanning Unit KDB Dissolution Unit KPA Purification Cycle KPB Solvent Recovery Cycle KPC Acid Recovery Unit KPF Silver Recovery Unit KWD Liquid Waste Reception Unit KWG Offgas Treatment Unit MDE Medium Depressurization Exhaust System NBX Primary Blend Ball Milling Unit NBY Scrap Milling Unit NCR Scrap Processing Unit NDD PuO_2 Container Opening & Handling Unit NDP Primary Dosing Unit NDS Final Dosing Unit NPE, NPF Homogenization & Pelletizing Unit NTM Jar Storage & Handling Unit NXR Powder Auxiliary Unit PAD Pellet Repackaging Unit PAR Scrap Box Loading Unit PFE, PFF Sintering Units PML Pellet Handling Unit POE Process Cell Exhaust System PQE Quality Control and Manual Sorting Units PRE, PRF Grinding Units PSE Green Pellet Storage Unit PSF Sintered Pellet Storage Unit PSI Scrap Pellet Storage Unit PSJ Ground and Sorted Pellet Storage Unit PTE Pellet Inspection and Sorting Units	PWS Plant Water System RDO Diluent System RHN Hydroxylamine Nitrate System RHP Hydrogen Peroxide System RHZ Hydrazine System RMN Manganese Nitrate System RNA Nitric Acid System ROA Oxalic Acid System RSC Sodium Carbonate System RSH Sodium Hydroxide System RSN Silver Nitrate System RTP Tributyl Phosphate System SAS Service Air System SCE Rod Scanning Unit SDK Rod Inspection and Sorting Unit SEK Helium Leak Test Unit SGF Standby Diesel Generator Fuel Oil System SPS, SPC Process Steam and Process Condensate Systems STK Rod Storage Unit SXE, SXF X-Ray Inspection Units TAS Assembly Handling and Storage Unit TCK Assembly Dry Cleaning Unit TCL Assembly Final Inspection Unit TCP Assembly Dimensional Inspection Unit TGM Assembly Mockup Loading Unit TGV Assembling Mounting Unit TXE Assembly Packaging Unit VHD Very High Depressurization Exhaust System VRM Radiation Monitoring Vacuum System WVA Vehicle Access Portal

EXECUTIVE SUMMARY

On October 31, 2002, Duke Cogema Stone & Webster (DCS or the applicant) submitted to the U.S. Nuclear Regulatory Commission (NRC) a revised construction authorization request (CAR), pertaining to a proposed Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF) on the U.S. Department of Energy's (DOE) Savannah River Site (SRS). If NRC approved construction of the MFFF, the MFFF would be a key asset of DOE's Surplus Plutonium Disposition Program (SPDP). The SPDP is being implemented as a result of a bilateral agreement with the Russian Federation. The U.S. and the Russian Federation agreed that each nation would convert 37.5 U.S. tons (34 metric tons) of weapons-grade plutonium (declared excess to national security needs) into forms less usable in nuclear weapons. The SPDP would convert surplus U.S. weapons-grade plutonium into MOX fuel. In implementing its SPDP, the DOE decided in early 2002 not to pursue its immobilization option for the disposition of surplus weapons-grade plutonium. The DOE decided to instead convert all such material into MOX fuel. As a result of this decision, design changes to the proposed MFFF were required in order to accommodate material containing greater amounts of impurities, as reflected in the revised CAR.

The revised CAR replaces, in its entirety, the CAR submitted by DCS on February 28, 2001. The purpose of this revised CAR is to describe changes necessary to process plutonium feed materials from DOE sources other than the proposed Pit Disassembly and Conversion Facility (PDCF), incorporate information previously provided in DCS' responses to NRC's requests for additional information and provide additional information to address open items identified in the NRC staff's initial Draft Safety Evaluation Report (DSER), issued on April 30, 2002. The revised CAR also contains general information about the applicant and information about the ability of the proposed facility to resist natural phenomena and consequences of potential accidents. In support of its revised CAR, DCS had previously submitted several items to the NRC, including a Quality Assurance Plan, Revision 3 (dated March 26, 2002) and a revised Environmental Report (dated July 11, 2002). In this revised DSER, the NRC staff documents its review and conclusions concerning the revised CAR and the other safety-related information submitted by DCS in support of its revised CAR.

Pursuant to 10 CFR Part 70, applicants seeking authorization to construct a plutonium processing and fuel fabrication facility must obtain NRC approval before starting construction. The regulation governing construction, 10 CFR 70.23(b), states that NRC will approve construction of the principal structures, systems and components (PSSCs) of a plutonium processing and fuel fabrication facility if the NRC finds that the design bases of the PSSCs and the quality assurance program provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents.

DESCRIPTION OF THE FACILITY

The MFFF that DCS proposes to build would receive depleted uranium (DU) dioxide (DUO_2) and plutonium dioxide (PuO_2), purify the plutonium dioxide to remove impurities such as gallium and americium, fabricate MOX fuel consisting of uranium and plutonium dioxides, assemble fuel rods and fabricate fuel assemblies. The completed fuel assemblies would be subsequently irradiated in commercial nuclear power plants authorized by the NRC to use MOX fuel. The design of the MFFF is based on aspects of the LaHague and Melox facilities in France.

The site of the proposed MFFF is in F-Area of DOE's SRS in southwest South Carolina near Aiken. The MFFF would be located near the proposed PDCF, a facility which the DOE plans to build and operate. The proposed PDCF would not be under the NRC's jurisdiction. The F-Area is restricted, and there are no unrestricted public roads in the vicinity. Nearby, the principal body of water is the Savannah River, which forms the SRS's southwest boundary. The MFFF site encompasses approximately 41 acres (0.17 km^2), of which, approximately 17 acres (0.07 km^2) would be developed with roads, facilities, or buildings if the revised CAR is approved. No roads, railroads, or waterways now traverse the MFFF site.

The main MFFF building would be the MOX fuel fabrication building. This building would contain all of the plutonium dioxide handling, fuel processing, and fuel fabrication operations of the MFFF. Plans call for a reinforced concrete building having a footprint of approximately 300 feet (91.4 m) by 450 feet (137 m), and this building would be approximately 73 feet (22.3 m) above grade. The MOX fuel fabrication building would have three major functional areas as follows: the MOX processing area, the aqueous polishing (AP) area, and the shipping and receiving area. In the AP area, plutonium dioxide (PuO_2) received from the proposed PDCF and other DOE sources would be purified as referenced above. This PuO_2 would be transported to the shipping and receiving area of the MFFF in approved shipping containers and would be unloaded and inspected in accordance with material control and accounting (MC&A) and radiation protection programs. The MFFF would receive depleted uranium dioxide (DUO_2) at the material receipt area of the secured warehouse building, where it would also be inspected in accordance with MC&A and radiation protection programs. The DUO_2 would be trucked to the shipping and receiving area of the MFFF as needed for processing. After leaving the AP area and entering the MOX processing (MP) area in the main processing building, the purified PuO_2 would then be blended with DU powder and processed into MOX fuel and, ultimately, fuel assemblies. Fresh MOX fuel assemblies would be stored in the assembly storage vault in the MFFF before shipping offsite. For shipping to the candidate commercial power plants, the assemblies would be moved to the shipping and receiving area of the MFFF where they would be loaded into an NRC-approved MOX fresh fuel transportation package, and then loaded onto a secure transport vehicle for transport to the commercial power plants for irradiation.

SAFETY OF THE FACILITY

Potential accidents evaluated by the applicant include loss of confinement of licensed nuclear material, fire, load handling events, explosions, nuclear criticality, natural phenomena events, external man-made events, external exposure, and those related to chemical interactions. The set of natural phenomena hazards identified by the applicant and evaluated by the staff include earthquakes, high wind, tornadoes and tornado-generated missiles, extreme temperatures, rain, snow, ice, lightning, and fires external to the MFFF. For most of the postulated hazards, the applicant has chosen a mitigation strategy, but for the explosion and nuclear criticality hazards, the applicant has chosen a prevention strategy. In revised DSER Chapter 5, the staff reviews the methodology used by the applicant in performing the safety assessment of the facility design bases, to determine if the safety assessment adequately considered all appropriate natural phenomenon, external man-made, and internal process hazards. The NRC staff reviewed the applicant's hazard assessments, the formulation of a safety strategy and the identification of PSSCs to meet the 10 CFR 70.61 performance requirements. To approve the revised CAR, the staff will need to find that the applicant's safety assessment describes an adequate strategy which, if effectively applied, will ensure that the 10 CFR § 70.61 performance requirements will be met, should the facility later be authorized to operate. In Chapter 5 of this draft Safety Evaluation Report, the staff evaluates the hazards that have been addressed by DCS, and finds that most, but not all, of these hazards are adequately controlled by the PSSCs designated by DCS. Issues that remain unresolved include the explosion potential related to tri-butyl phosphate (i.e., "red oil") and hydroxylamine nitrate (HAN), the adequacy of the criticality safety validation report, the adequacy of fire barriers, and the performance of high efficiency particulate air (HEPA) filters.

A complete list of the unresolved or open items is provided in Appendix A. The open items are discussed in the relevant chapters of the revised DSER. Items that were open in the staff's April 30, 2002, DSER that have since been resolved are discussed in Appendix B.

SUMMARY

The staff concluded in a separate Safety Evaluation Report, and in Chapter 15 of this revised draft Safety Evaluation Report, that the Quality Assurance program at the proposed MOX facility will provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents. The scope of this conclusion pertains to the construction of the facility's principal SSCs, and includes all related design, procurement and fabrication activities, but does not include any start-up testing or operation of the proposed facility.

In the revised DSER, the NRC staff concludes that DCS has not met all of the applicable requirements pertaining to construction of the proposed MFFF. Based on the staff's review of the revised CAR and supporting information provided by the applicant, the staff finds that, due to the open items discussed in the revised DSER, DCS has not met the Baseline Design Criteria (BDC) set forth in 10 CFR 70.64(a). Further, until the open items are closed, the staff cannot conclude, pursuant to 10 CFR 70.23(b), that the design bases of the PSSCs identified by the applicant will provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents.

The revised DSER is a snapshot of the NRC staff's present positions, based on information received to date. The staff's review will continue, and the staff expects to issue a final safety evaluation report on the proposed MFFF construction after evaluating further information to be submitted by DCS.